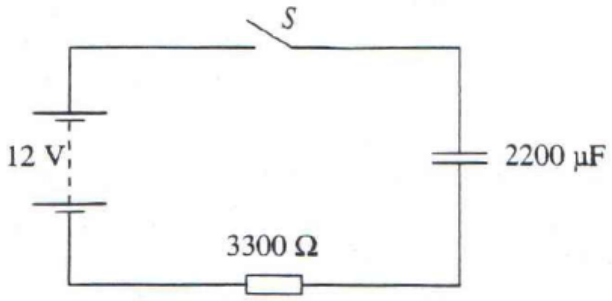
Higher Grade Physics

Unit 3 : ELECTRICITY

Capacitance

Charging and Discharging

1. The diagram shows a 12 V battery connected to a 2200 μF capacitor and a 3300 Ω resistor in series.



   (a) Sketch graphs to show how (i) the p.d. across the capacitor and (ii) the current in the resistor vary once the switch *S* is closed.

   (b) What is the p.d. across the capacitor (i) immediately after the switch is closed and (ii) once the capacitor is fully charged?

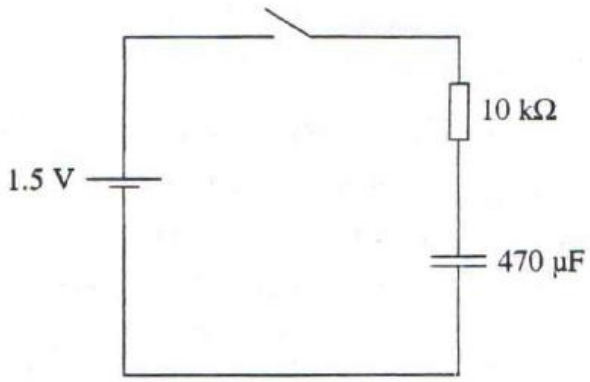
   (c) Calculate the current flowing in the resistor immediately after the switch is closed.

2. A 1.5 V cell is connected to a 470 μF capacitor and a 10 kΩ resistor in series.

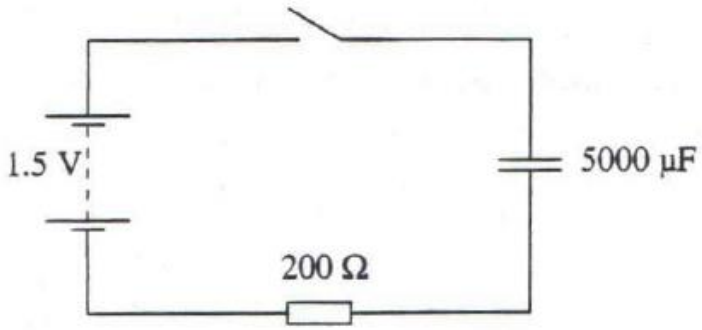
   (a) Sketch a graph to show the variation of the p.d. across the capacitor during charging. Label this graph **A**.

   (b) On the same axes sketch a possible graph of p.d. against time if a 220 μF is used in place of the 470 μF capacitor. Label this graph **B**.

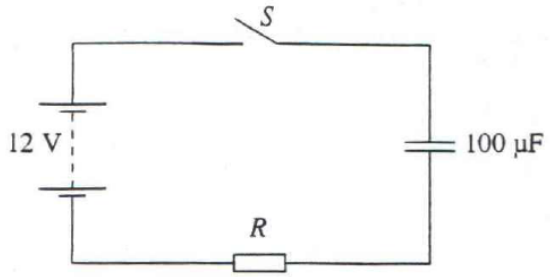
   (c) Now sketch the graph of p.d. against time which could be obtained using a 470 μF capacitor and a 33 kΩ resistor. Label this graph **C**.



3. A 1.5 V cell is connected as shown to a 200 Ω resistor and a 5000 μF capacitor in series. What is the initial charging current?



4. A 100 µF capacitor is charged using a 12 V battery as shown.



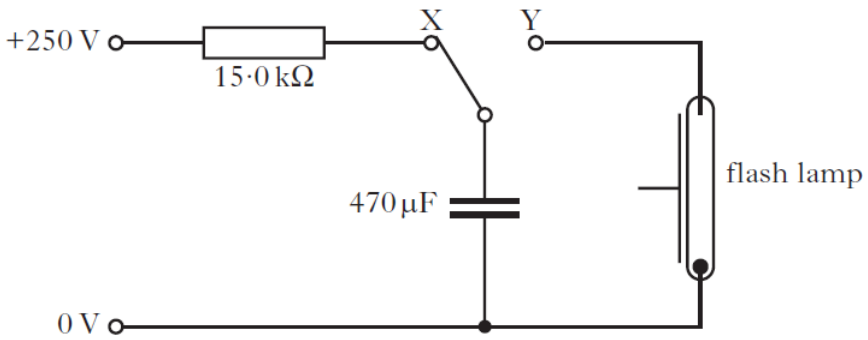
(a) Sketch a graph of p.d. against time.
(b) On the same axes sketch the graph which would be obtained if a 9V battery were used in place of the 12V battery.

5. A capacitor is charged to a potential difference of 24 V and then discharged through a 600 Ω resistor. What is the initial discharging current?

6. A capacitor is connected directly to a 9.0 V battery and then discharged through a resistor. If the initial discharging current is 15 mA, what is the value of the resistance?

7. A capacitor is connected in series with a 200 Ω resistor and charged using a 24 V supply.
(a) What is the initial charging current.
(b) When the capacitor is partly charged the p.d. across it is found to be 15 V.
(i) What is the current now?
(ii) What is the p.d. across the resistor?

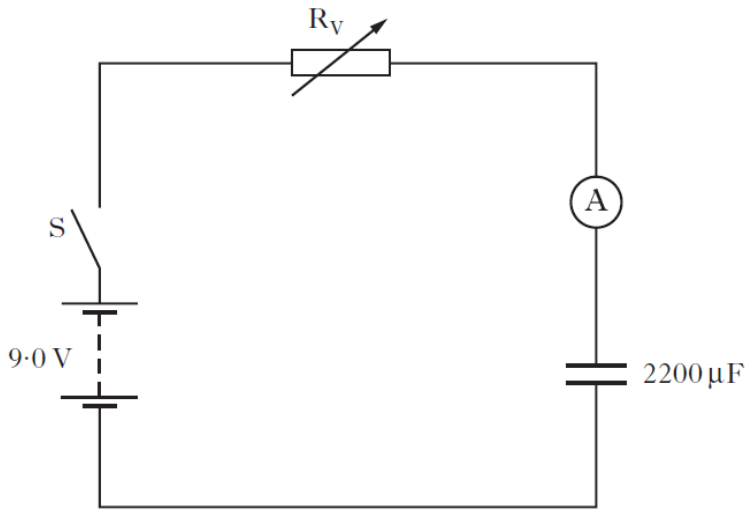
8. Part of a camera flash circuit operates at 250 V d.c. as shown below. The capacitor is initially uncharged.



(a) The capacitor is now charged by connecting the switch to X.
(i) Calculate the initial charging current.
(ii) Sketch a graph to show how the voltage across the capacitor varies with time from the moment the switch is connected to X. Numerical values are required on the voltage axis.

(b) The time for the capacitor to charge in a camera flash is known as the recycle time. How could the circuit be modified to reduce the recycle time without altering the power output of the flash?

9. A student sets up the circuit shown to investigate the charging of a capacitor.



Initially the capacitor is uncharged and the variable resistor R_V is set to 12 kΩ.

(a) Switch S is now closed and the capacitor charges.
Sketch a graph of the current in the circuit from the time the switch is closed until the capacitor is fully charged.
Numerical values are only required on the current axis.

(b) Capacitors have an insulator between their plates.
Explain why there is a current in the circuit during the charging process.

(c) Switch S is now opened and the capacitor is fully discharged. The variable resistor is adjusted to a greater resistance.
Switch S is closed and the capacitor charges again.
Explain what effect, if any, this increase in resistance has on :
(i) The maximum potential difference across the capacitor;
(ii) The maximum current in the circuit.

Q = VC

10. What is the capacitance of a capacitor which stores 50 mC of charge when connected to a 1.5 V cell?

11. How much charge is stored by a 2200 µF capacitor connected to a 12 V battery?

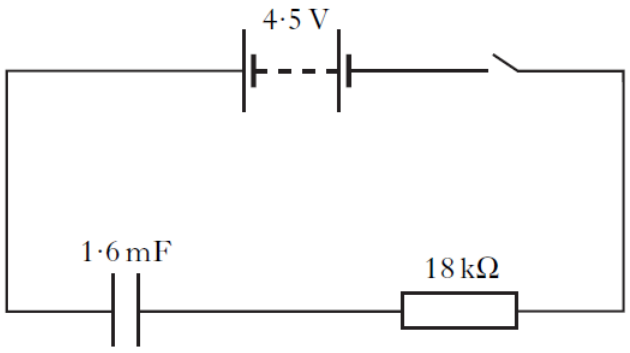
12. A 470 µF capacitor stores 500 µC of charge. What is the p.d. across the capacitor plates?

13. How much charge is stored by each of the following capacitors?
    (a) a 20 µF capacitor charged to a voltage of 1.5V
    (b) a 4 µF capacitor charged to a voltage of 400 V
    (c) a 2200 µF capacitor charged to a voltage of 12 V
    (d) a 500 pF capacitor charged to a voltage of 9.0 V
    (e) a 20 pF capacitor charged to a voltage of 24 V

14. Find the capacitance of each of the following capacitors
    (a) a capacitor which stores 12 mC of charge when the p.d. is 150 V
    (b) " " " 1.5 mC " " " 6.0 V
    (c) " " " 3.6 C " " " 24 kV
    (d) " " " 120 µC " " " 12 V
    (e) " " " 50 µC " " " 25 kV

15. What is the potential difference across each of the following capacitors?
    (a) a 10 000 µF capacitor storing 50 mC of charge
    (b) a 220 µF " " 10 µC " "
    (c) a 0.01 µF " " 500 mC " "
    (d) a 240 pF " " 12 mC " "

16. Part of a circuit in an electronic timer consists of a 1.6 mF capacitor and an 18 kΩ resistor connected to a switch and a 4.5 V supply.



    (a) Calculate the charge on the capacitor when it is fully charged.

    (b) Sketch the graph of current in the resistor against time as the capacitor charges. Numerical values are required on the current axis.

Energy Stored

17. How much energy is stored by a capacitor which holds 50 mC of charge at a p.d. of 12 V?

18. A capacitor stores 25 mJ of energy when it is charged to a p.d. of 100 V. What is the charge on the capacitor?

19. If a capacitor stores 0.04 J of energy when holding 200 mC of charge, what is the p.d.?

20. Find the energy stored in each of the capacitors *of Questions 13, 14* and *15*.

21. Find the potential difference required in each of the following cases
    (a) a 1000 μF capacitor storing 0.50 J of energy.
    (b) a 220 μF capacitor storing 4.0 J of energy

22. What value of capacitor would be required to store 400 mJ of energy at a potential difference of 12 V?

23. What value of capacitor would be required to store 720 mJ of energy when holding 60 mC of charge?

24. Find the charge stored in each of the following
    (a) a 470 μF capacitor storing 50 mJ of energy.
    (b) a 5000 μF capacitor storing 10 J of energy.